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| (54) Title: GROUTING PIPE EQUIPMENT AND METHOD OF GROUTING USING THE SAME FOR AN UNDERGROUND WATER WELL   |                            |  |
| (57) Abstract   |                            |  |
| The present invention relates to a grouting pipe equipment for underground water wells and a grouting method wherein concrete is cured on the interior wall of a bore hole in order to prevent a contaminated surface water and the like from flowing in the water well which is excavated for extraction of groundwater for use. Particularly, the present invention is concerned with a grouting pipe equipment for underground water wells and a grouting method using the same wherein an incasing (3) is installed in a suitable location by inserting the incasing (3) into a water well as deep as necessary and then, the concrete to be cured is supplied into the targetted area, thereby preventing inflow of the surface contamination, etc. into the water well. |                            |  |

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## SPECIFICATION

## TITLE OF THE INVENTION

Grouting Pipe Equipment and Method of Grouting Using the Same for an  
5 Underground Water Well

## FIELD OF THE INVENTION

The present invention relates to a grouting pipe equipment for underground water wells and a grouting method, wherein concrete is cured on the interior wall of a  
10 bore hole in order to prevent a contaminated surface water and the like from flowing in the water well which is excavated for extraction of groundwater for use. Particularly, the present invention is concerned with a grouting pipe equipment for underground water wells and a grouting method using the same, wherein an incasing is installed in a suitable location by inserting the incasing into a water well as deep as necessary and  
15 then, the concrete to be cured is supplied into the targetted area, thereby preventing inflow of the surface contamination, etc. into the water well.

## BACKGROUND ART

A conventional arrangement for extraction of groundwater, as illustrated in Fig.  
20 1, comprises:

an outcasing (1) of a large diameter which is installed for prevention of collapse of a stratum of weathered rock, this installation of an outcasing just following the drilling of the earth from the surface to a bedrock layer with a well drilling machine of a certain diameter;

an incasing (3) which is installed for the purpose of preventing inflow of surface water, the installation of an incasing being implemented after installation of said outcasing (1) and the subsequent further drilling of the bedrock layer until the perforation of a nappe;

5 a strainer pipe (18) which is installed at a position beneath said incasing (3) where a groundwater flows, for the purpose of preventing the entering of soil and sand or a foreign substance;

the concrete which is cured by injection into the space between the incasing (3) and the interior wall of the water well for the purpose of preventing the entering of soil  
10 and sand or a foreign substance;

a water pump (20) which is installed inside said incasing (3); and,

a water-lifting pipe (22) which is connected to said water pump (20) and allows flow of a groundwater therethrough.

Said water pump (20) is turned on and off by means of an upper level sensor  
15 (53) and a lower level sensor (54), both of which are set on said water-lifting pipe (22). And, inside said incasing (3) is also provided a water gauge pole (34) by virtue of which a water table can be monitored to the extent of a certain depth.

In this conventional technology, it is quite common that for attempting to secure a sufficient amount of groundwater that can meet the contracted amount, an  
20 outcasing is driven into as shallow as around the middle of the weathered rock layer, but which is supposed to be embedded into as deep as a certain depth of the bedrock layer. There even was a case where a bore was intentionally formed on the outcasing to induce surface water to flow in. Furthermore, an incasing for grouting was generally not installed for a typical water well, and even if an incasing of a synthetic resin was

sometimes driven in a water well, a grouting process for prevention of the entering of surface water was not implemented in most cases. Accordingly, quite a few cases have happened where surface water was flowed in a water well for groundwater with no interference, resulting in the pollution of wells.

5        Most commonly, an incasing was inserted in a pre-drilled water well simply without a grouting process. In this method, however, it has been found to be problematic in that it is basically impossible to prevent contamination by the permeation of surface water, for the depth of insertion of an incasing could not but be restricted.

In another conventional, the so called orthodox method of grouting for  
10 prevention of permeation of surface water in excavation for obtaining groundwater, first,  
a bore hole of a large diameter is drilled to the extent of the surface of a bedrock layer  
for the sake of interposing an outcasing. Secondly, after completion of the insertion of  
an outcasing, a curing process subsequently follows by injecting concrete into the inside  
of the outcasing, and thirdly, a further excavation is continued down to the place where  
15 it reaches a nappe of groundwater, in order to form a bore hole of a small diameter  
which can accommodate an incasing. However, this method exhibits a deficiency of the  
economic inefficiency, because, according to this method, the grouting process has to be  
carried out without knowing the exact total amount of the groundwater available from a  
water well, resulting in an excessive cost for initial excavation. And it is more defective  
20 in consideration of the fact that if the contracted amount of groundwater were not  
secured, the excavated bore with a driven-in incasing could not but be abandoned after  
the grouting process is completed.

In order to solve the problems as aforementioned, an alternative method is suggested, wherein a bedrock stratum is excavated as deep as to the upper layer of the

stratum to insert an outcasing, and then, for the insertion of an incasing, the drilling bit is changed to a small-diameter one to continue to excavate as deep as to where a nappe of groundwater is present, and finally, concrete is grouted into the annular space between the incasing and the interior wall of the drilled bore hole for curing, the step of  
5 which is for the purpose of preventing the entering of surface water.

This method, however, suffers from the fact that it is difficult to grout the concrete from the lower portion. Were it assumed that it is possible to grout it from the lower portion, the contamination of groundwater cannot be avoided owing to a leakage of the concrete into the water well. Moreover, if the concrete is grouted from the upper  
10 portion, such a narrow annular space as being about 50~60mm in width may probably not be fully compacted or tamped with the concrete since the so called bridging effect which is an inherent nature of concrete will take place at an intermediate depth or so. As a result, the optimal effect expected from the grouting process cannot be achieved. Another problem exists in that since the grouting process is carried out in such  
15 circumstance where the water table has already risen, the concrete would often be diluted by blending with the groundwater present between the incasing and the interior wall of the bore hole, thereby rendering it impossible to cure the concrete, or difficult to obtain a sufficient strength by a suitable concentration of the concrete. Accordingly,  
where the water quality is important, the grouting process has to be implemented  
20 repeatedly, for example, twice or thrice, with the result of enormous additional expenses for construction.

As an alternative in which a grouting process is to be carried out only after the confirmation of the potential yield of groundwater, the bedrock layer with a pre-drilled water well is filled with sand from the depth of a nappe up to a certain height; then, the

place is covered with lumps of clay or wooden boards for keeping the seal even in water; the concrete is grouted from the upper portion for curing; then, excavation is continued as deep as to the location where said lumps of clay or wooden boards are present; the sand is eliminated by discharging the same through the surging process,  
5 then finally, followed by insertion of an incasing.

However, this approach in itself has a drawback in that if the central axis of the incasing does not coincide with the shaft of a pre-drilled bore hole, it will become impossible to use in the construction, with the result of development loss. Still further, if the material for sealing cannot serve properly, the concrete is possibly to be injected  
10 even into the nappe, and to cut the nappe off. Hence, the quantity of attainable water is considerably decreased.

In addition to the problems as aforementioned, the conventional methods suffer from the fact that when a bore hole is excavated using a well drilling machine, the bore hole is susceptible to being curved to some extent due to the different constituents of the  
15 bedrock layer, so that the central axis of the bore hole will not be kept straight, and therefore, a linear incasing cannot be inserted as deep as necessary, thereby resulting in an inferior grouting.

What is worse with the conventional methods, the concrete infiltrates the nappe, to contaminate the water or reduce the amount of attainable water. This is because, in  
20 these methods, the dependability of the cutoff means cannot be secured sufficiently to shield the nappe from concrete in a perfect manner.

On the other hand, the use of all these methods and apparatus as described so far is limited to for an underground water well of a large diameter, while individual houses in rural villages, farms, and other small-scale constructions generally exploit

such underground water wells as having less than 50mm in diameter. In this connection, there has not been provided a grouting method and apparatus suitable for excavation of these small-diameter water wells. And, when it is intended to extract groundwater from these small wells by using a conventional method and apparatus, unexpected troubles 5 are possibly caused where the quality of water is deteriorated in an extremely rapid manner, or it is found difficult to obtain water of good quality.

#### DETAILED DESCRIPTION OF THE INVENTION

The present invention has been invented in order to remedy the aforementioned 10 problems. Particularly, the present invention contemplates providing a grouting pipe equipment and a grouting method suitable for use for underground water wells, which enable a more facile and economic implementation of grouting. This purpose is accomplished by setting the central axis of a bore hole to coincide with that of a grouting pipe while installation; by securing a bore hole of a desired diameter; by 15 preventing leakage of the liquid grout into the water well, this prevention being achieved by perfectly isolating the water well area from the grouting area through a superior grouting treatment, thereby realizing a perfect prevention of the entering of surface contamination.

In order to achieve the goal as aforementioned, with respect to a grouting pipe 20 equipment for underground water wells by using which a sealing wall is made in a bore hole for attempting to prevent the contaminated surface water from entering the water well, the present invention comprises:

an incasing with corrugation tubes formed thereon at regular intervals which enables the incasing to be inserted into a curved bore hole; and

an expansion tube that is installed at the lower portion of said incasing, by virtue of which the annular space between the interior wall of the bore hole and the incasing is obstructed.

With respect to a grouting pipe equipment for underground water wells by  
5 using which a sealing wall is installed in a bore hole for attempting to prevent inflow of the polluted surface water into a water well, the present invention comprises:

an incasing with corrugation tubes formed thereon at regular intervals which enables the incasing to be inserted into a curved bore hole;

10 a large shielding pipe installed at the lower portion of said incasing for the purpose of cutting off the liquid grout;

an expansion tube which is installed along the periphery of said shielding pipe by means of which the liquid grout is cut off;

15 a protective circular board of a bigger diameter than that of said shielding pipe, which is provided at the upper and lower portions of said shielding pipe lest said expansion tube should get damaged;

a liquid-grout supply tube which is installed between said incasing and the interior wall of said bore hole and through which the liquid grout passes; and

a compressed fluid injection hose through which a compressed fluid is supplied to said expansion tube from the utmost surface.

20 With respect to a grouting pipe equipment of a small diameter for underground water wells which can further serve as a water-lifting pipe and by using which a sealing wall is installed in a bore hole for attempting to prevent the entering of the surface contamination into a water well of a small diameter, the present invention comprises:

an incasing with corrugation tubes formed thereon at regular intervals which

enables the incasing to be inserted into a curved bore hole;

an expansion tube which is installed at the lower portion of said incasing for the purpose of circumferentially obstructing the space between the interior wall of a pre-drilled bore hole and said incasing in a manner of isolating the spaces from each other;

5 and

a pressure compensation equalizer tube of a small diameter which is installed inside said incasing.

With respect to a drilling bit guiding device equipped with an expansion tube for underground water wells, the present invention is characterized in that:

10 said guiding device, the body of which is originally of uniform diameter, is made to develop into an inverted cone shape by progressively and proportionally reducing the diameter of its body downwardly from a certain point of the upper portion, and continually, the body is made to have a lower portion of a uniform diameter from at a certain height of its body, thereby the body of the guiding device being rendered a  
15 funnel shape;

an expansion tube is provided along the periphery of the body of said guiding device, and a tube band is attached thereon for fixing;

several ball bearings are circumferentially installed at the periphery of the body of said guiding device at its lower portion, for the purpose of maintaining a uniform  
20 annular space during insertion, thereby achieving facility in protection and insertion of the expansion tube;

a couple of pulleys are provided at each side of the body of said guiding device at its upper portion so that a wire rope winding the body can be extended outside by way of these pulleys.

With respect to the method of grouting for underground water wells wherein a sealing wall is installed in a bore hole for attempting to prevent the entry of surface contamination into the bore hole, the method comprises:

the first step of installing an outcasing after drilling a bore hole of a large  
5 diameter passing through a stratum of weathered rock until reaching a bedrock stratum;

the second step of installing an incasing of a smaller diameter than that of said outcasing, after drilling a bore hole of a small diameter until finding of a nappe which is located in the bedrock stratum; and

the third step of obstructing the annular space between the periphery of said  
10 incasing and the interior wall of the bore hole, with a shielding means, then followed by a curing process by injecting liquid grout into said incasing from lower portion.

With respect to the method of grouting for underground water wells, in which a sealing wall is installed in a bore hole for attempting to prevent the entry of contaminants from surface water into the bore hole, the method comprises:

15 the first step of installing an outcasing after drilling a bore hole of a large diameter passing through a layer of the weathered rock stratum until reaching the bedrock stratum;

the second step of installing an incasing of a smaller diameter than that of said outcasing inside the outcasing at a certain location of the bedrock stratum, while  
20 shielding or obstructing the annular space between the outer circumference of the incasing and the interior wall of the bore hole, at lower portion, by using a shielding means;

the third step of securing a bedrock groundwater by drilling a bore hole of a small diameter as deep as to a nappe present in the bedrock stratum; and

the fourth step of curing concrete by injecting liquid grout into from a lower place where the shielding by said expansion tube is implemented up toward the surface.

## 5 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an outlined cross-sectional view of the conventional groundwater extraction equipment.

Fig. 2 is an outlined cross-sectional view of the grouting pipe equipment according to the invention.

10 Fig. 3 is a partial cross-sectional view of the incasing in the first embodiment according to the invention.

Fig. 4 is a front view of the incasing in the first embodiment according to the invention.

15 Fig. 5 is a partial perspective view of the cutting portion in the first embodiment according to the invention.

Fig. 6 is an outlined cross-sectional view of the grouting pipe equipment in the second embodiment according to the invention.

Fig. 7 is a partial cross-sectional view of the incasing in the second embodiment according to the invention.

20 Fig. 8 is a front view of the incasing in the second embodiment according to the invention.

Fig. 9 is a partial perspective view of the connection portion in the second embodiment according to the invention.

Fig. 10 is a developed perspective view of the tube band in the second

embodiment according to the invention.

Fig. 11 is a partial cross-sectional view of the grouting pipe equipment in the third embodiment according to the invention.

Fig. 12 is a partial cross-sectional view of the incasing in the third embodiment  
5 according to the invention.

Fig. 13 is an exploded perspective view indicating the connection portions of the incasing, and a partial cross-sectional view and a perspective view indicating the connection status in the third embodiment according to the invention.

Fig. 14 is a cross-sectional view of the grouting pipe equipment for a  
10 groundwater well, which also serves as a water-lifting pipe, in the fourth embodiment according to the invention.

Fig. 15 is a cross-sectional view of an installation of the expansion tube in the fourth embodiment according to the invention.

Fig. 16 is a cross-sectional view of the check valve in the fourth embodiment  
15 according to the invention.

Fig. 17 is an exploded perspective view of the check valve in the fourth embodiment according to the invention.

Fig. 18 is a cross-sectional view of the well mounted with a drilling bit guiding device with the expansion tube for a groundwater well in the fifth embodiment  
20 according to the invention.

Fig. 19 is a cross-sectional view of the drilling bit guiding device for a groundwater well equipped with the expansion tube in the fifth embodiment according to the invention.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

The first embodiment of the extraction apparatus employing a grouting pipe equipment for the groundwater well according to the invention, as shown in Fig. 2 to  
5 Fig. 5, comprises:

an outcasing (1) installed passing through a part of the weathered rock layer and the bedrock layer from the surface;

an incasing (3) installed near groundwater for the purpose of preventing an influx of contaminated surface water, which is gapped with the inner wall of a bore hole  
10 drilled through the weathered rock layer and the bedrock layer, and formed with corrugation tubes (12) thereon at the interval of a fixed distance for the easier insertion into an even curved bore hole;

bearings (16) installed at the interval of a fixed distance from the lower portion of said incasing (3);

15 a strainer pipe (18) installed under said incasing to filter an alien substance in the groundwater, and formed with corrugation tubes (12) at every fixed distance for the installation at the curved bore hole;

a well pump (20) installed inside said incasing (3) to extract groundwater;

20 a water-lifting pipe (22) connected to said well pump (20) to allow the groundwater to flow up to the ground;

an expansion tube (5) installed at the section of a reduced diameter (14) of the lower potion of said incasing (3);

a rubber tube (51) installed at the outer circumference of said expansion tube (5) for maintaining secure attachment of said expansion tube (5) to the outer periphery of

the incasing (3) before expansion, and for uniform expansion when expanding;

a compressed-fluid injection hose (7) connected to said expansion tube (5) via an interior or an exterior of said incasing (3) from the ground in order to provide a compressed fluid to said expansion tube (5);

5 a soft cover plate (24) installed over said expansion tube (5) to protect said expansion tube (5) from the concrete; and

a liquid-grout supply tube (26) installed via an interior of said incasing (3) from the ground to allow the concrete to be injected between said incasing (3) and said bore hole.

10 Further, in the case that a compressed-fluid injection hose (7) is installed inside the incasing (3), a cutting blade (28) for cutting the compressed-fluid injection hose (7), a guide (30) for guiding said cutting blade (28), and a cutting portion (56) which is furnished with a passage hole (67) for supporting the hose (7) during the cutting process are attached onto the interior wall of the incasing (3), after which a pulling string (32) 15 connected to the cutting blade (28) is extended for withdrawing the same up to the ground.

Still further, said bearings (16) as shown at Fig. 3, is mounted on the outer periphery of said incasing (3).

20 Additionally, an upper level sensor (53) and a lower level sensor (54) are installed at the predetermined position of the water-lifting pipe (22), which enable groundwater to be extracted when the groundwater table is up to the predetermined level, and a water gauge pole (34) is installed at one side of the incasing (3).

The second embodiment according to the invention will become apparent from accompanying drawings and the description of the components which are the same with

that of the first embodiment will be omitted.

The groundwater extraction apparatus employing a grouting equipment for a groundwater well according to the invention, as shown in Fig. 6 to Fig. 10, comprises:

- an outcasing (1);
- 5 an incasing (3) installed near groundwater for the purpose of preventing an influx of contaminated surface water, which is gapped with the inner wall of a bore hole drilled through the weathered rock layer and the bedrock layer, and formed with corrugation tubes (12) thereon at the interval of a fixed distance for easier insertion into an even curved bore hole;
- 10 a plate spring (82) installed to maintain the fixed interval between the bore hole and the incasing (3);
  - a strainer pipe (18) installed under said incasing (3) to filter an alien substance in groundwater, and formed with corrugation tubes (12) thereon at every fixed distance for the installation even at the curved bore hole;
- 15 a well pump (20) installed inside said incasing (3) to lift the groundwater;
  - a water-lifting pipe (22) connected to said well pump (20) allowing the groundwater to flow up to the ground;
  - an expansion tube (5) installed at the outer periphery of said incasing (3);
    - a protective expansion tube (57) installed at the outer periphery of the internal 20 expansion tube (58), to allow said expansion tube (5) to be expanded uniformly and to guarantee a shield even at the protrusion portion formed at the inner wall of the well;
    - a compressed-fluid injection hose (7) connected to the expansion tube (5) via interior of said incasing (3) from the ground in order to provide a compressed fluid to said expansion tube (5);

a soft cover plate (24) installed at the upper portion of said expansion tube (5) to protect the expansion tube (5) from the liquid grout; and

5 a liquid-grout supply tube (26) installed, starting from the ground, at the space between said incasing (3) and said bore hole to allow the liquid grout to be injected therethrough.

Here, the tube band (94) fixes the expansion tube (5) to the outer periphery of the incasing (3), as shown at Fig.10.

Said tube band (94) is formed with a metal belt having several vents (70) on one side, and on the other side, a welded metal bar (61) which has an equal width to that of 10 the metal belt and some protrusion parts (78) allowing insertion of itself into the vents (70).

The method of fixing and uniting the expansion tube (5) comprises;  
surrounding the periphery of the expansion tube (5) with the tube band (94);  
inserting the protrusion parts (78) of the metal bar (61) into the vents (70) of the 15 metal belt; and

fixing the overlapped portion between the metal bar (61) and metal belt with a fixing clip(60).

Further, a plate spring (82) is mounted on the periphery of the incasing (3) with every constant interval, keeping the gap between the incasing (3) and the inner wall of 20 the bore hole constant, said plate spring (82) being outwardly circular-shaped and fixed and attached only with its lower portion.

Additionally, as shown at Fig. 9, the invention comprises a lower connection portion (86) and an upper connection portion (85) at the ends of the incasing (3) pipe to connect several incasings (3) to said incasing (3) for extension,

said lower connection portion (86) being formed with some cut parts (87) including V-shaped grooves, with a little larger diameter than that of the upper connection portion (85), and

5 said upper connection portion (85) being formed with the number of vertically elongated protrusions (90) at the periphery, corresponding to said cut parts (87).

Further, while at lower connection portion (86) are formed some perforations (89), same number of perforations (89) are also formed at the corresponding position of said upper connection portion (85).

Where the incasing pipes constituted as above are connected with each other, the  
10 upper connection portion (85) of the upper incasing pipe is inserted for assembly into the lower connection portion (86) of the lower incasing pipe, and the protrusions (90) at the outer periphery of the upper connection portion (85) are fitted into the cut parts (87) of the lower connection portion (86). Subsequently, the perforations (89) of the upper connection portion (85) meet the perforations (89) of the lower connection portion (86),  
15 combining two incasing pipes firmly when bolted. As such, the extended length of the pipes can vary depending on depth.

The first method of construction using the grouting pipe equipment for groundwater as described above according to the invention comprises:

excavating a weathered rock layer and partially a bedrock layer using a drilling  
20 bit of a large diameter; and

installing an outcasing (1) on the inner wall of the bore hole for the purpose of preventing collapse of the bore hole and inflow of the contaminated surface water.

Once the installation of said outcasing (1) is completed, the drilling bit of a large diameter is replaced by the one of a small diameter, to excavate to the position through

which the groundwater passes. Then, the strainer pipe (18) is inserted and installed at the position where the groundwater flows, followed by the insertion of said incasing (3) into the upper portion of said strainer pipe (18) for installation.

At this time, with the help of some bearings (16) or plate springs (82) installed at 5 the lower portion of said incasing (3), said incasing (3) can be inserted easily even into a curved bore hole without scratching the inner wall or getting stuck onto it. Additionally, said incasing (3) can maintain a constant gap from the inner wall of the bore hole by these bearings (16) or plate springs (82) installed at every fixed interval.

If said incasing (3) is installed properly, the compressed fluid is injected through 10 the compressed-fluid injection hose (7) into the expansion tube (5) mounted along the lower periphery of the incasing (3). At this time, the expansion tube (5) is expanded uniformly by the rubber band (51), or the internal expansion tube (58) of the expansion tube (5) is expanded uniformly together with the protective expansion tube (57), serving as a shielding plate. In this way, when the compressed fluid is injected into said 15 expansion tube (5), the gap between the incasing (3) and the inner wall of the bore hole gets sealed. Once this first sealing is completed, the liquid grout is provided through the liquid-grout supply tube (26).

The second method of construction using the grouting pipe equipment as described above according to the invention comprises:

20 excavating a weathered rock layer and partially a bedrock layer using a drilling bit of a large diameter; and

installing an outcasing (1) on the inner wall of the bore hole for the purpose of preventing collapse of the bore hole and inflow of the contaminated surface water.

Once the installation of said outcasing (1) is completed, the incasing (3) is

installed, wherein the expansion tube (5) for protection from the contaminated surface water is provided at the outer periphery of the lower part of the incasing (3), guaranteeing a secure shielding.

Then, the bore hole is excavated to the groundwater nappe in the bedrock layer  
5 using the drilling bit of a small diameter.

When a groundwater bedrock nappe is secured, a curing process follows in such a manner that the liquid grout is injected into the gap from the lower part of the incasing, where a shielding is made by the expansion tube (5), up toward the surface.

Here, as shown at Fig. 3, said liquid-grout supply tube (26) is replaced by the  
10 common straight-line tube (26-1) when the gap between the incasing (3) and the bore hole is narrow. The common straight-line tube is installed in the same manner as with the said compressed-fluid injection hose (7), that is, it is connected to the upper part of the expansion tube (5) through the interior of the incasing (3). The cutting blade (28) connected with the pulling string (32) at the lower portion of the connection part and the  
15 guide (30) guiding the movement of said cutting blade (28) are mounted on the inner wall of the incasing (3), thereby cutting the tube (26-1) after the curing of the concrete is completed.

At this time, the contaminated surface water is not mixed since the liquid concrete is provided through the liquid-grout supply tube (26) in such a way that it  
20 pushes the contaminated surface water present in the gap between the incasing (3) and the bore hole up toward the surface. And, the better curing is achieved since the bridge effect in which the liquid concrete is not fully compacted does not occur. Further, since the soft cover plate (24) (or including the internal expansion tube (58) and the protective expansion tube (57)) is mounted on the upper part of the expansion tube (5), damage of

the expansion tube (5) by the injection of the liquid concrete for grouting can be prevented beforehand.

Then, when the curing is finished by injecting the liquid concrete into the gap between the incasing (3) and the inner wall of the bore hole, the compressed-fluid injection hose (7) is cut by pulling the pulling string (32). Additionally, in the case that the straight-line tube (26-1) is mounted on the interior of the incasing (3) as a liquid-grout supply tube (26), the straight-line tube (26-1) is cut by pulling said pulling string (32). And the compressed-fluid injection hose (7) and the liquid-grout supply tube (26) already cut are collected from the interior of the incasing (3).

When the construction is completed as described above, the water-lifting pipe (22) and the well pump (20) are finally installed inside the incasing (3), thereby allowing pumping of groundwater.

In a third embodiment according to the present invention, as shown in Fig.12, first of all, the bedrock layer is dug up to the point of a certain depth for preventing the contaminated surface water from soaking into an internal wall of the bore hole, by using a bit of a large diameter as in the case for digging into the weathered rock layer. Then, it is dug to a nappe of groundwater using a bit of a small diameter and an incasing (3) having corrugation tubes (12) is installed.

The lower part of the incasing (3) is provided with a shielding pipe (55) having a certain length. And, the upper part and the lower part of the pipe are respectively provided with an upper protective circular board (36) and a lower protective circular board (38) both of which have larger diameter than that of the shielding pipe (55). An outer periphery of the shielding pipe (55) is provided with an expansion tube (5). The expansion tube (5) is protected by the upper protective circular board (36) and the lower

protective circular board (38) both of which are provided at the upper part and the lower part of the shielding pipe (55), in order to prevent damage when the incasing pipe is inserted into the bore hole. In addition, the outer periphery of the lower protective circular board (38) is provided with a bearing (16) serving as a guide when the incasing 5 (3) is inserted. As seen from the structure employing a plate spring provided with a predetermined interval along the outer periphery of the incasing, the plate spring keeps a constant interval between the incasing (3) and the internal wall of the bore hole so that a thickness of the grouted concrete can be kept constant even in a curved bore hole.

In addition, as in the first embodiment, a soft cover plate (24) is provided 10 between the upper protective circular board (36) and the expansion tube (5), and a rubber band (51) is provided outside the expansion tube (5) to protect the expansion tube (5) and to effectuate a uniform expansion thereof.

As in the first embodiment, a compressed-fluid injection hose (7) which injects the compressed-fluid into the expansion tube (5) is connected to the expansion tube (5) 15 via outside of an incasing (3) and a soft tube (26) is provided between the incasing (3) and the internal wall of the bore hole of a large diameter.

As an another embodiment, as shown in Fig.11, the compressed-fluid injection hose (7) is connected to the expansion tube (5) via outside of the incasing (3), wherein the intake of the expansion tube (5) is made by incising the body of the incasing (3) 20 partly in a vertical direction, by inserting the compressed-fluid injection hose (7) of the same material as the incasing (3) into the incision part, and by welding the hose (7) for finish. Then, a connector (13) for connecting the compressed-fluid injection hose (7) is engaged to an end of the intake. The compressed-fluid injection hose (7) is protected against an outer impact by being providing with a coil spring (71) outside the

compressed-fluid injection hose (7) which is extended. And a liquid-grout supply tube (26) for injecting the concrete for grouting is provided between the incasing (3) and the inside wall of the bore hole of a large diameter.

The operation of the present invention with the above structure will be  
5 described as follows. First of all, the weathered rock layer and the bedrock layer are dug to a certain depth, where an inflow of the contaminated surface water is prevented, by using a bit of a large diameter. And the rocks are dug by a bit of a small diameter from the depth until the groundwater nappe is penetrated. Then, a strainer pipe (18) is provided near the groundwater nappe and the incasing (3) with the shielding pipe (55),  
10 etc. mounted on is inserted up to a depth where the lower protective circular board (38) is hang on a lower end of the bore hole of large diameter and then the compressed fluid is injected to the expansion tube (5) through the injection hose (7) so that the expansion tube (5) expands to block between the upper space and the lower space thereof.

Here, the interval between the shielding pipe (55) and the internal wall of the  
15 bore hole dug by the bit of large diameter is very small to cause an expansion rate of the expansion tube (5) to be small so that little damage of the expansion tube (5) occurs during an expansion. When concrete liquid is injected through the liquid-grout supply tube (26), a load of the concrete is dispersed by the upper protective circular board (36) so that a load imposed on the expansion tube (5) is reduced to protect the expansion  
20 tube (5) safely. A concrete wall cured between the incasing (3) and the bore hole is formed to be thick to obtain a complete sealing effect.

In addition, in case cement, urethane or epoxy resin, etc. is used as the compressed fluid injected into the expansion tube (5), the primary sealing effect is obtained through a fast curing to attain the stable sealing performance against a load of

concrete for grouting injected secondarily.

And, in case of a connection of the incasing as shown in Fig.13, a structure adjusting an length extension of the pipe according to the depth of the well may be employed by covering an upper circumference ring (96) and a lower circumference ring 5 (97) positioned opposite to the ring (96) with a packing (99), the rings respectively formed by bending and upper connection portion part of one incasing (3) and a lower connection portion of the other incasing (3) perpendicularly outside in order to make flat junction surfaces and by covering and engaging the upper circumference ring (96) and the lower circumference ring (97) by a semi circular couplers 98 having a 'ε' shaped section.

As mentioned above, when the grouting process is finished, a pipe for water pumping and a well pump (20) are inserted into the incasing (3) and an extraction of groundwater is started.

In addition, Fig. 14 is a sectional diagram of a grouting and water pumping pipe 15 device for groundwater well in the fourth embodiment of the present invention. Fig. 15 is a sectional diagram of a part where the expansion tube is provided in the fourth embodiment of the present invention. Fig. 16 is a sectional diagram showing a check valve in the fourth embodiment of the present invention. Fig. 17 is a perspective diagram showing the check valve in the fourth embodiment of the present invention. 20 The fourth embodiment of the present invention has a similar structure to the second embodiment of the present invention as shown in the figures so that different parts will be explained hereinafter based on the second embodiment.

The pipe for water pumping and grouting according to the present invention comprises an outcasing (1), an incasing (3), an plate spring (82), an expansion tube (5),

an injection hose for the compressed fluid (7), a cover plate (24), and an liquid-grout supply tube (26). Its structural characteristic is same as in the second embodiment and the differences is as follows. When a screw junction part (63) is provided for an extension of the incasing (3), the screw is formed in a round screw shape for a convenience of junction. A water pump provided on the ground can be connected directly to the grouting and water pumping pipe by applying a connection accessory device (62) to the uppermost end of the incasing (3).

A female screw is provided in an upper end of a connection accessory device (62) and a pressure compensation equalizer tube (68) is provided in the incasing (3), and in case of using a hose of different material, a pendulum (59) is provided to be hung on the lowermost part of the pressure compensation equalizer tube (68) for a convenience of a setting up. A filter barrel (64) having the check valve (72) for the equalizer tube at its lower end is provided above the pipe so that contaminated materials may not inflow into the well in case air inflows into the equalizer tube (68). A contra-injection tube (65) with a valve for adjusting fluid amount (66) mounted is provided between the check valve (72) for the equalizer tube and the connection accessory device (62) and is connected to an outlet side of the water pump.

And, after a lowermost end of the incasing is bent inwards as shown in Fig. 16 and Fig. 17, a packing is applied at the lower part and an opening (77) is formed for passing groundwater. A hollow sliding pole (75) is provided at the upper part, the rod being connected to the pressure compensation equalizer tube (68), and at the lower part, a hollow check valve seat (21) is positioned for a convenience of a connection with the pressure compensation equalizer tube (68), the check valve seat (21) connected to the pressure compensation equalizer tube at the upper and the lower sides.

In addition, a hollow round plate shaped check valve circular board (69) with a cylindrical guide (74) thereon is inserted to cover the check valve seat (21). The lower surface of the check valve circular board (69) and the upper surface of the check valve seat (21) are contacted closely. And the upper part of a cylindrical guide (74) of the 5 check valve circular board (69) is stressed by an elastic force of a spring (84) provided to cover the pressure compensation equalizer tube (68).

A construction method using the grouting and water pumping pipe for groundwater well of small diameter according to the present invention constructed as above comprises a grouting step as mentioned above, a connecting step of the pump 10 pipe to the connection accessory device (62) at the upper end of the incasing (3) by the pipe connection accessory after the liquid-grout has been cured, a provision step of the check valve (72) for the equalizer tube, a provision step of the pressure compensation equalizer tube (68) near a bottom of the well by using a connection port of the pressure compensation equalizer tube (68) at the upper part of the pipe connection accessory, and 15 a connection step of the valve for adjusting fluid amount (66) and the contra-injection tube (65) and the water pumping pump.

When water is filled into an impeller casing of the water pumping pump and then power is supplied under a closure state of the valve for adjusting fluid amount (66) on the contra-injection tube (65) in order to extract groundwater after finishing every 20 construction work, groundwater is moved up from a natural water level in the incasing (3) while the pressure compensation equalizer tube (68) is moved downwards from the natural water level so that an excessive negative pressure is prevented in the incasing (3).

In case of groundwater well of a low depth, it is possible that air inflows into

the well, resulting in an incapability state of the water pumping due to air sucked in by the water pumping pump. For meeting the problem, when a water level is moved up to the natural water level in the well at a rest state of the water pumping pump on a first operation of the water pumping pump, a certain amount of groundwater from the water pumping pump is injected into the lower part of the well through the pressure compensation equalizer tube (68), while closing the valve for adjusting fluid amount (66) of the contra-injection tube (65) gradually after opening fully the valve (66) of the contra-injection tube (65). Therefore, air inflows continuously into the well to prevent air from congesting in the water pumping pump and an invariable balance is made between groundwater flowing in through the water nappe and groundwater flowing into the lower part of the well through the contra-injection tube (65) so that the water pumping may be in a proper operation without any hindrance under a normal short time control operation in the well of small diameter.

When the pump is stopped, the water level goes down. The check valve (76) at the lower end of the grouting pipe, which is provided for preventing the water level from going down excessively, the excessive decrease of water level resulting in an incapability of water pumping, when the pump operates later, prevents a leakage of groundwater in the grouting pipe since the check valve seat (70) and the check valve circular board (69) contacts closely due to the weight of the pressure compensation equalizer tube (68) and the pendulum, the weight of groundwater on the grouting pipe and the force of the spring (84) when the pump stops. Groundwater filled in the incasing (3) makes the water pumping operation to start easily when the pump operates.

And, when the check valve (76) has a problem, the check valve seat (70) and the check valve circular board (69) can be drawn out easily by disassembling the upper

part of the pipe connection accessory and by pulling up the pressure compensation equalizer tube (68), resulting in a convenient maintenance work.

Hereinafter, the fifth embodiment according to the present invention will be described in detail with respect to the accompanying drawings. Fig. 18 is a sectional diagram showing the well provided with an guiding device for the drilling bit for the groundwater well on which the expansion tube according to the fifth embodiment of the present invention is mounted. Fig. 19 is a sectional diagram for the guiding device for the drilling bit for the groundwater well on which the expansion tube in the fifth embodiment of the present invention is mounted. Parts which have not been explained 5 in a following explanation about this invention have the same structures as those in the first embodiment.

As shown in Figures, the inside diameter of the upper portion of guiding device (33) is formed to be same as the grouting pipe to make easy the connection with the grouting pipe. The inside diameter is designed to decrease in proportion from a certain 15 position from its top end, resulting in the inverted corn shaped upper part. Then, the lower portion of guiding device (35) having the same inside diameter through its height is formed from a certain position, resulting in the body of guiding device (31) of a funnel shaped section. Here, the inside diameter of the lower portion of guiding device (35) is formed a little larger than the diameter of the drilling bit of small diameter.

20 And, a hole (17) for the compressed fluid injection hose (7) is formed from the inside of the body of guiding device (31) to the circumference surface of the upper portion of guiding device (33). In addition, the expansion tube (5) is positioned on the circumference surface of the body of guiding device (31) and then is fixed by a tube band (94). The expansion tube (5) comprises an outside soft expansion tube and an

inside hard expansion tube integrally formed so that a watertight property is obtained even with the rough inside wall of the groundwater well when the expansion tube (5) expands, and a steady expansion force can be attained as well.

In addition, a bearing (16) is provided in a circumference surface of the lower 5 portion of guiding device (35) to keep an interval for an insertion invariable in the insertion process and to protect the expansion tube (5) against the inside wall of the groundwater well and to facilitate its insertion. Pulleys (93) are provided respectively at either side of the upper portion of guiding device (33) so that a wire rope (92) can be led to the outside, winding the body of guiding device (31) through the pulleys (93). A 10 guidance ring (37) is applied to the upper portion of guiding device (33) to prevent the wire rope (92) from moving off the pulleys (93).

Now, an operation of the present invention will be explained. A body of guiding device (31) of the invention is connected to the grouting pipe in the well of large diameter which extends to the bedrock line, the line being reached at a primary 15 excavation, on an excavation of groundwater well of large diameter. The wire rope (92) for drawing is inserted to the pulleys (93) and is taken down to the bottom of the bore hole of large diameter. In this case, the diameter of the upper portion of guiding device (33) is the same as the outer diameter of the grouting pipe known so that the grouting pipe can be assembled or welded to the body of guiding device (31).

When the insertion of the grouting pipe and the body of guiding device (31) 20 into the groundwater well is finished, the compressed fluid is injected to the expansion tube (5), which is mounted on the body of guiding device (31) at the lowermost end of the grouting pipe, to expand the expansion tube (5). A center of the bore hole of large diameter and a center of the body of guiding device (31) are made to correspond

through the expansion process, and a steady compression effect is obtained between the expansion tube (5) and the inside wall of the groundwater well by the expansion force of the expansion tube (5).

As a result, an inflow of the contaminated surface water from the surface layer  
5 of the earth is stopped at its rising state up to a certain water level due to the sealing by the expansion of the expansion tube (5) and then a bore hole of small diameter is dug using a drill having a bit of small diameter replaced, and the digging process is continued until the groundwater nappe of bedrock is founded. Here, the drilling bit of small diameter reaches the top end of the body of guiding device (31) through the inside  
10 of the grouting pipe, and the drilling bit is positioned at an exact central position along a slope in the body of guiding device (31). A certain height of a lower end cylindrical part (90) acts as a guidance for a stable excavation in the early excavation process of the bit of small diameter.

In addition, the grouting pipe is fixed steadily due to the compression force  
15 between the expansion tube (5) and the inside wall of the well on the digging process so that the digging process can be continued stably without any unnecessary vibration even under the compressed air of high pressure.

In case a bedrock groundwater nappe is found during the digging process, the wire rope (92) inserted in the upper portion of guiding device (33) is drawn out by  
20 unfastening its one end and by pulling its other side end through the pulleys (93). Then, the digging process is finished after injecting the liquid-grout from the lower position and performing a curing process.

In case a bedrock groundwater nappe is not found, an expansion pressure of the compressed fluid in the expansion tube (5) is removed to restore the original shape of

the tube. Then, the grouting pipe and the body of guiding device (31) can be drawn out easily by pulling both sides of the wire rope (92) together with the grouting pipe.

In case the drilling bit guiding device of a smaller diameter is used instead of the guiding device of the same diameter as the grouting pipe, the grouting pipe of small diameter is inserted after fixing of centers on the early excavation process, and the liquid-grout is filled between the circumference surface of the grouting pipe and the internal wall of the groundwater well. Here, in order to prevent a leakage of the liquid-grout, a round plate shaped ring (39) is welded to the lowermost end of the grouting pipe and, under the ring, a soft O-ring packing (83) is inserted tightly on the circumference surface of the grouting pipe to contact the round plate shaped ring (39).

When the grouting pipe structured as above is inserted into the drilling bit guiding device for the groundwater well, the O-ring packing (83) is to be hung at the middle depth of the slope (88) of the corn shaped guiding device, and the round plate shaped ring (39) supports the O-ring packing (83) so that a tight sealing is obtained by the weight of the grouting pipe to prevent a leakage of the liquid-grout.

As mentioned above, the grouting pipe device and the grouting method for the groundwater well based on the present invention offer effects as follows. That is, the incasing can be inserted to the desired depth without being stuck even in the bent bore hole so that a reliability of the grouting is improved, and a steady sealing is accomplished by the expansion tube to perform a perfect grouting while preventing contamination of water and a blockage of a nappe of groundwater. The grouting can be carried out easily even in a ground well already exploited as well as a groundwater well under an exploitation.

In addition, the grouting pipe for groundwater well of small diameter according

to the present invention can be used as a water pumping pipe, in addition to effects mentioned above. And, an inflow of the contaminated surface water of the earth into the groundwater well of small diameter is prevented so that the clean groundwater can be obtained and an economic and convenient grouting work can be carried out.

5 In addition, the present invention forms the solid grouting water-proof wall having no gap so that the problems resulting from disagreement of the center of the grouting pipe and that of the groundwater well on the exploitation of the well of large diameter are solved, in addition to preventing inflows of the contaminated surface water. An excavation to the groundwater nappe in the bedrock layer is possible without inflow  
10 of the contaminated surface water by unifying the grouting pipe and the body of the guiding device, and the grouting pipe and the body of the guiding device which have already been inserted can be drawn out easily in case of a withdrawal for a non-discovery of a groundwater nappe.

## CLAIMS

What is claimed is:

5        1. Grouting pipe equipment for an underground water well for constructing a sealing wall which is installed in a bore hole for preventing an inflow of polluted surface water into the bore hole drilled for extracting groundwater, which comprises:

an incasing 3 with corrugation tubes 12 thereon at regular intervals for inserting into a curved bore hole;

10        an expansion tube 5 which is installed at the lower portion of said incasing 3 for sealing the gap space between the interior wall of the bore hole and the incasing 3.

2. Grouting pipe equipment according to Claim 1, wherein said incasing 3 has a section of a reduced diameter 14 at its lower portion.

15

3. Grouting pipe equipment according to Claim 1, which comprises bearings 16 for guiding to facilitate insertion along the periphery of said incasing 3.

4. Grouting pipe equipment according to Claim 1, wherein:

20        said expansion tube 5 is a cylindrical tube body which is situated in the outer periphery of said incasing 3, the upper and lower portions of which are fixed with a tube band 94;

      said tube band 94 is made with a metal belt having several vents 70 at one end and a weld-attached metal bar 61 of the same width as that of the metal belt, at the other

end, said metal bar 61 having a projection 78 therewith for insertion of itself into the vents 70; and

    said expansion tube 5 is fixed with a fixing clip 60 for a fixed joint.

5

5. Grouting pipe equipment according to Claim 1, wherein:

    said expansion tube 5 comprises an internal expansion tube 58 located at the inner portion, which expands by a direct contact with the injected fluid, and a protective expansion tube 57 of a soft material containing foams, which is located outside said internal expansion tube 58, said internal expansion tube 58 and said protective expansion tube 57 being contacted with each other to form a unitary body.

10

6. Grouting pipe equipment according to Claim 1, wherein:

    plate springs 82 which are circumferentially spaced at regular intervals are provided along the outer periphery of said incasing 3 for keeping a constant distance between the interior wall of a bore hole and the incasing 3 during insertion of said incasing 3; and

    said plate spring 82 is round-shaped and outward-curved with its lower portion being fixed and attached while the upper portion thereof being not fixed.

20

7. Grouting pipe equipment according to Claim 1, wherein:

    said incasing 3 comprises an lower connection portion 86 and an upper connection portion 85 at its upper and lower ends, respectively, said lower connection portion 86 of a little larger diameter than that of said upper connection portion 85 having several cut parts 87 with v-shaped grooves, and said upper connection portion 85

having protrusions 90 of an elongated longish shape which are circumferentially spaced along its periphery, and the number of which is equal to that of said cut parts 87; and

said lower connection portion 86 has several perforations 89 thereon circumferentially and said upper connection portion 85 also has several perforations 89 at such positions as corresponding to those positions of the perforations 89 of said lower connection portion 86.

8. Grouting pipe equipment according to Claim 1, wherein:

an upper circumference ring 96 and an lower circumference ring 97 are formed 10 at the ends of said upper connection portion 85 and the lower connection portion 86, respectively, by folding each end outwardly with right angle, and thereby allowing said upper and lower circumference rings 96, 97 to have the flat junction surfaces therewith; and

after these surfaces are made to face with each other, the periphery thereof is 15 wrapped with a ring-shaped packing 99, and then followed by a step in which a pair of semi-circular couplers 98 the section of which is  $\square$ -shaped combine said upper circumference ring 96 and the lower circumference ring 97 with each other, whereby the pipe can afford to be extended in length depending on the depth of a bore hole.

20 9. Grouting pipe equipment according to Claim 1, which comprises:

a liquid-grout supply tube 26 for supplying liquid grout into the space between said incasing 3 and the bore hole; and

a compressed-fluid injection hose 7 which is connected to said expansion tube 5 for the purpose of supplying said expansion tube 5 with a compressed fluid.

10. Grouting pipe equipment according to Claim 9, wherein:

said liquid-grout supply tube 24 extends through inside of said incasing 3 in order to supply the space between the incasing 3 and the interior wall of a bore hole  
5 with liquid grout;

said compressed-fluid injection hose 7 is installed inside the incasing, with a cutting blade 28 formed therebeneath for the sake of cutting said compressed-fluid injection hose 7; and

a cutting section 56 is provided on the inner wall of said incasing 3, which  
10 includes a guide 30 wherein said cutting blade 28 moves up and down for cutting a hose, and a passage hole 67 for a hose.

11. Grouting pipe equipment according to Claim 9, wherein:

part of the pipe of the incasing 3 is cut out vertically, and said compressed-fluid  
15 injection hose 7 manufactured with the same material as said pipe of the incasing 3 is inserted in the empty space created by cutting, and then is welded for binding; and

a connector 13 for the compressed-fluid injection hose 7 is combined at the end of the opening for injection of a compressed fluid.

20 12. Grouting pipe equipment according to Claim 1, which comprises:

holes formed on said incasing 3 at its lower portion for screening foreign materials in groundwater, and a strainer pipe 18 with corrugation tubes thereon at regular intervals which enables the incasing 3 to be inserted into a curved bore hole.

13. Grouting pipe equipment for an underground water well for constructing a sealing wall which is installed in a bore hole for preventing an inflow of contaminants from surface water, which comprises:

an incasing 3 with corrugation tubes 12 thereon at regular intervals for  
5 inserting into a curved bore hole;

a pipe for sealing 55, which is provided at the lower portion of said incasing 3 for blocking the liquid grout;

an expansion tube 5 which is installed along the outer periphery of said pipe for sealing 55;

10 a pair of protective circular boards 36, 38 of a larger diameter than that of said shielding pipe 55, which are installed at the upper and lower portions of said shielding pipe 55 for preventing damage of said expansion tube 5;

a liquid-grout supply tube 26 which is installed for supplying liquid grout to the space between said incasing 3 and the interior wall of said bore hole;

15 a compressed-fluid injection hose 7 which is installed in such a way that a compressed fluid can be injected from the surface into said expansion tube 5 situated at lower portion of said incasing 3.

14. Grouting pipe equipment of a small diameter for an underground water  
20 well for constructing a sealing wall which is installed in a bore hole in order to prevent surface contamination from entering the water well, which can also serve as a water-lifting pipe, comprising:

an incasing 3 with corrugation tubes 12 formed thereon at regular intervals by virtue of which the incasing 3 can afford to be inserted into a curved bore hole,

an expansion tube 5 which is installed at lower portion of said incasing 3 for attempting to obstruct the annular space between said incasing 3 and the interior wall of a pre-drilled bore hole,

5 a pressure compensation equalizer tube 68 having a small diameter which is installed inside said incasing 3.

15. Grouting pipe equipment according to Claim 14, wherein:

said pressure compensation equalizer tube 68 is equipped with a filter tube 64 at its upper end, the function of which is filtering of contaminated dust and prevention 10 of inflow of contaminated surface water; and

the lowest end of said pressure compensation equalizer tube 68 is rendered close to the bottom of a water well.

16. Grouting pipe equipment according to Claim 14, wherein:

15 a valve 66 for adjusting the amount of fluid is provided for a contra-injection tube 65 that is connected to the discharge gate of a water-lifting pump; and

said contra-injection tube 65 is installed in such a way that it communicates with said pressure compensation equalizer tube 68.

20 17. Grouting pipe equipment according to Claim 14, wherein:

said incasing 3 is made bent inwardly at its lowest end;

a hollow sliding bar 75 which communicates with said pressure compensation equalizer tube 68 is installed inside said incasing 3 at upper portion; and

a hollow check valve seat 21 is provided at the lower portion of said hollow

sliding bar 75 for the sake of facility in connection of the bar to said pressure compensation equalizer tube 68;

said check valve seat 21 communicates with the pressure compensation equalizer tube 68 at its upper and lower portions;

5 a hollow check valve circular board 69 having a cylindrical guide 74 therewith at its upper portion is formed to cover said check valve seat 21 by fitting said check valve circular board 69 into said sliding bar 75, thereby rendering the bottom of said check valve circular board 69 and the surface of said check valve seat 21 being closely touched with each other;

10 the cylindrical guide 74 of said check valve circular board 69 comprises a coil spring 71 which is to be coiled around the pressure compensation equalizer tube 68.

18. A drilling bit guiding device equipped with an expansion tube for an underground water well, wherein:

15 the body 31 of said guiding device is originally of a uniform diameter but is made to develop into an inverted cone shape by progressively and proportionally reducing the diameter of the body downwardly from a certain point of its upper portion 33;

the body is continually made to have a lower portion 35 of a uniform diameter 20 from at a certain height of its body, thereby the sectional view of the body 31 of the guiding device becoming a funnel shape;

an expansion tube 5 is provided along the periphery of the body 31 of said guiding device and a tube band 94 is attached thereon for fixing;

several bearings 16 are provided along the periphery of the body of said

guiding device at its lower portion 35 for the purpose of maintaining a uniform annular space during insertion, resulting in facility in protection and insertion of the expansion tube 5;

a couple of pulleys 93 are provided at each side of the body 31 of said guiding device at its upper portion 33 so that a wire rope winding the body 31 can be extended outside by way of these pulleys 93.

19. A drilling bit guiding device according to Claim 18, wherein:

a circular board ring 39 is welded for binding to the lower portion of the incasing 3 that is combined with the body 31 of said guiding device; and

an O-ring packing 83 of soft material is fitted by force to the periphery of the incasing 3, thereby making it to contact with said circular board ring 39.

20. A method of grouting for an underground water well, in which a sealing wall is installed in a bore hole for prevention of inflow of the contaminants from surface water into the bore hole, which comprises:

the first step of installing an outcasing 1 after drilling a bore hole of a large diameter passing through a stratum of weathered rock until reaching the bedrock stratum;

20 the second step of installing an incasing 3 of a smaller diameter than that of said outcasing 1 inside the outcasing at a suitable location of the bedrock stratum after drilling a bore hole of a small diameter as deep as to a nappe which is located in the bedrock stratum; and

the third step of obstructing the space between the periphery of said incasing 3

and the interior wall of the bore hole, at lower portion of the space, with a shielding means, and of curing concrete by injecting liquid grout into from lower portion of the incasing up toward the surface.

5           21. A method of grouting for an underground water well, in which a sealing wall is installed in a bore hole for prevention of inflow of the polluted surface water into the bore hole, which comprises:

the first step of installing an outcasing 1 after drilling a bore hole of a large diameter passing through a stratum of weathered rock until reaching the bedrock  
10 stratum,

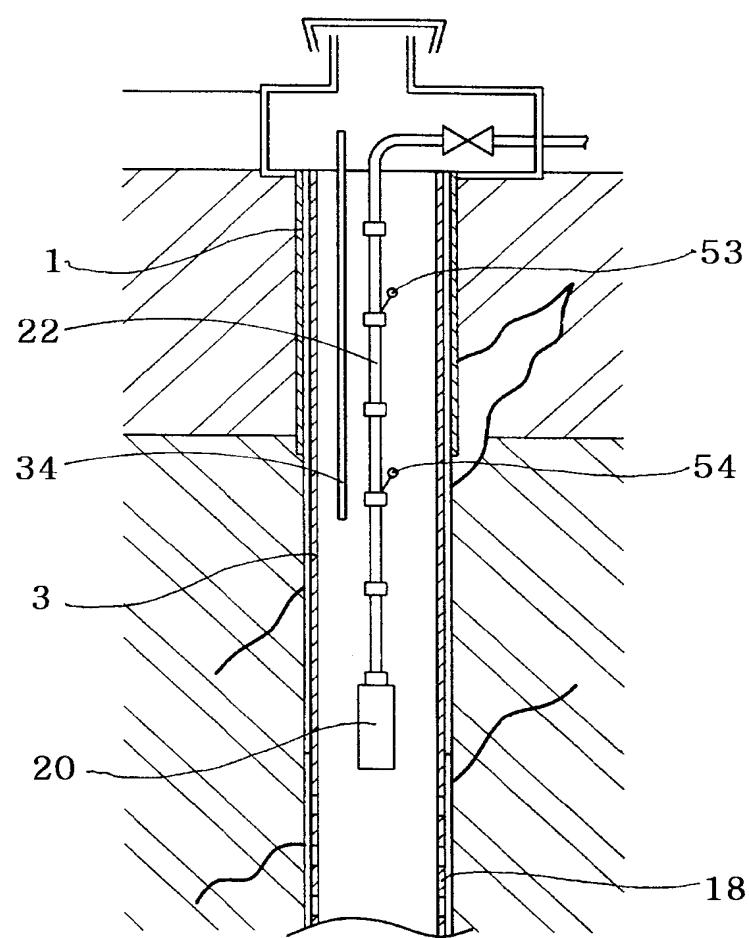
the second step of installing an incasing 3 of a smaller diameter than that of said outcasing 1 inside the outcasing 1 at a suitable location of the bedrock stratum, and of sealing the annular space between the periphery of the incasing 3 and the interior wall of the bore hole, at lower portion of the space, with an shielding means;

15           the third step of securing a bedrock groundwater by boring a bore hole of a small diameter as deep as to a nappe which is located in the bedrock stratum; and

the fourth step of curing concrete by injecting liquid grout into from a certain position of the lower portion up toward the surface, said position indicating the place where said shielding is implemented with an expansion tube 5 located at lower portion  
20 of the incasing 3.

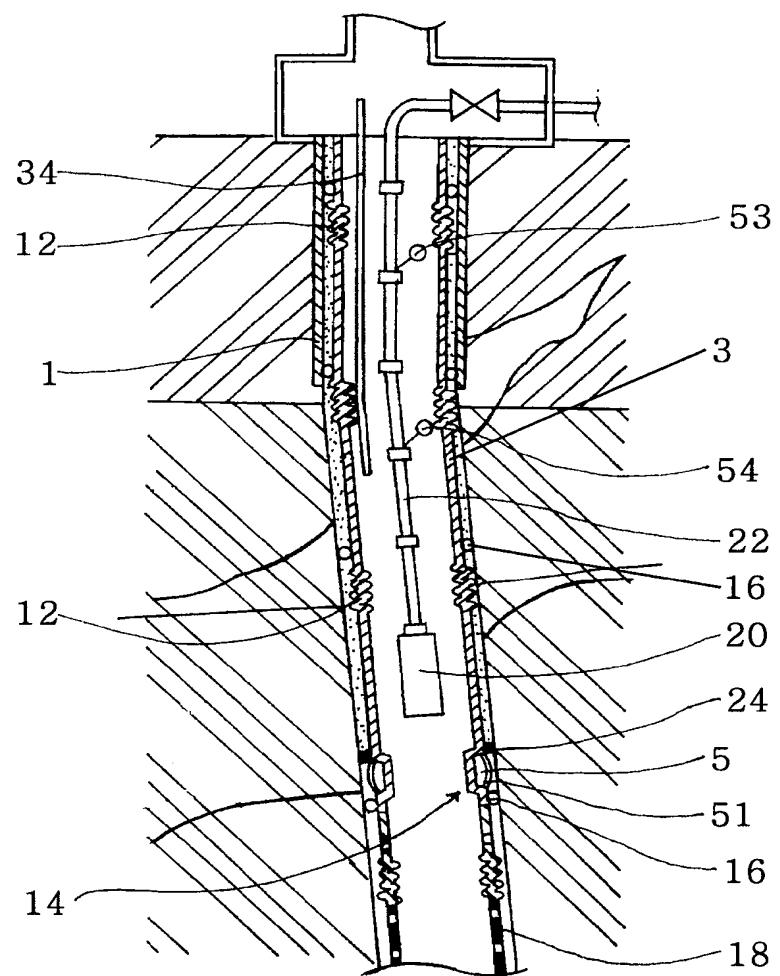
1/19

FIG.1



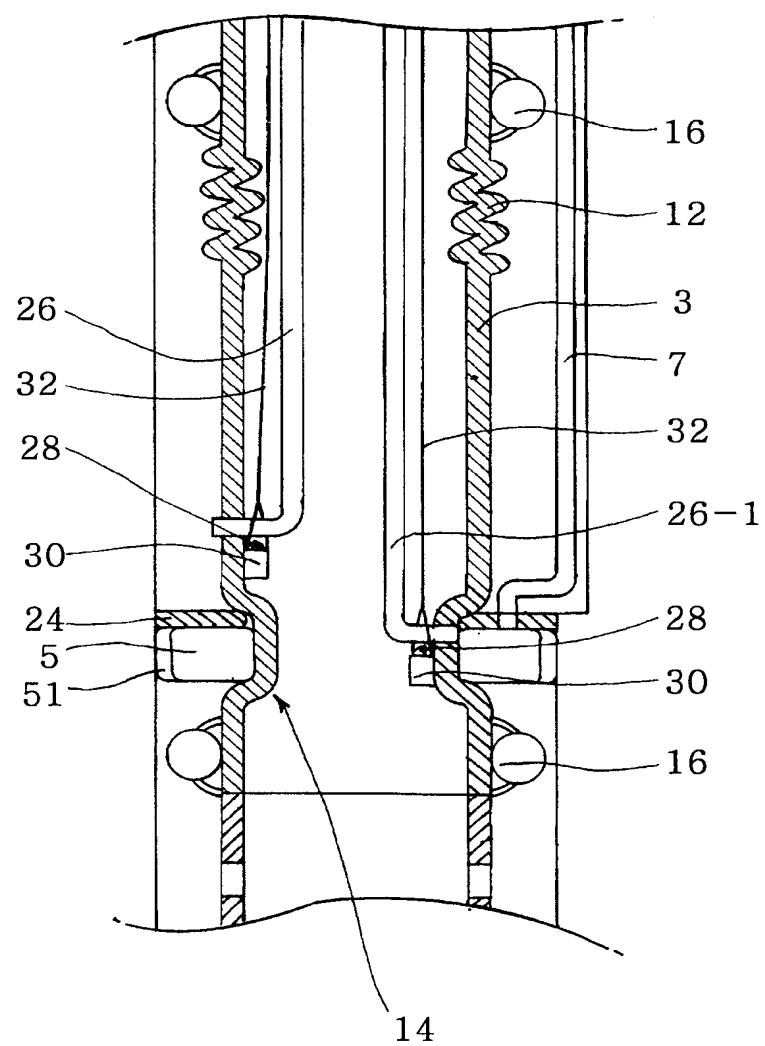
2/19

FIG.2



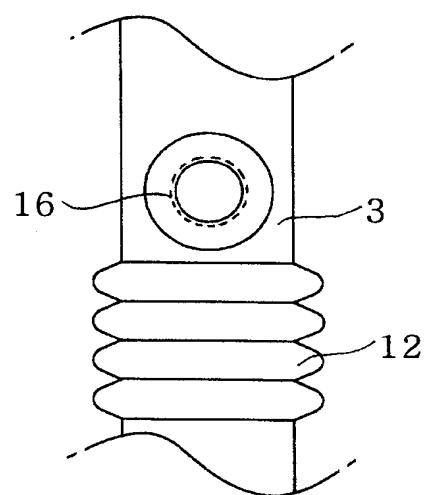
3/19

FIG.3



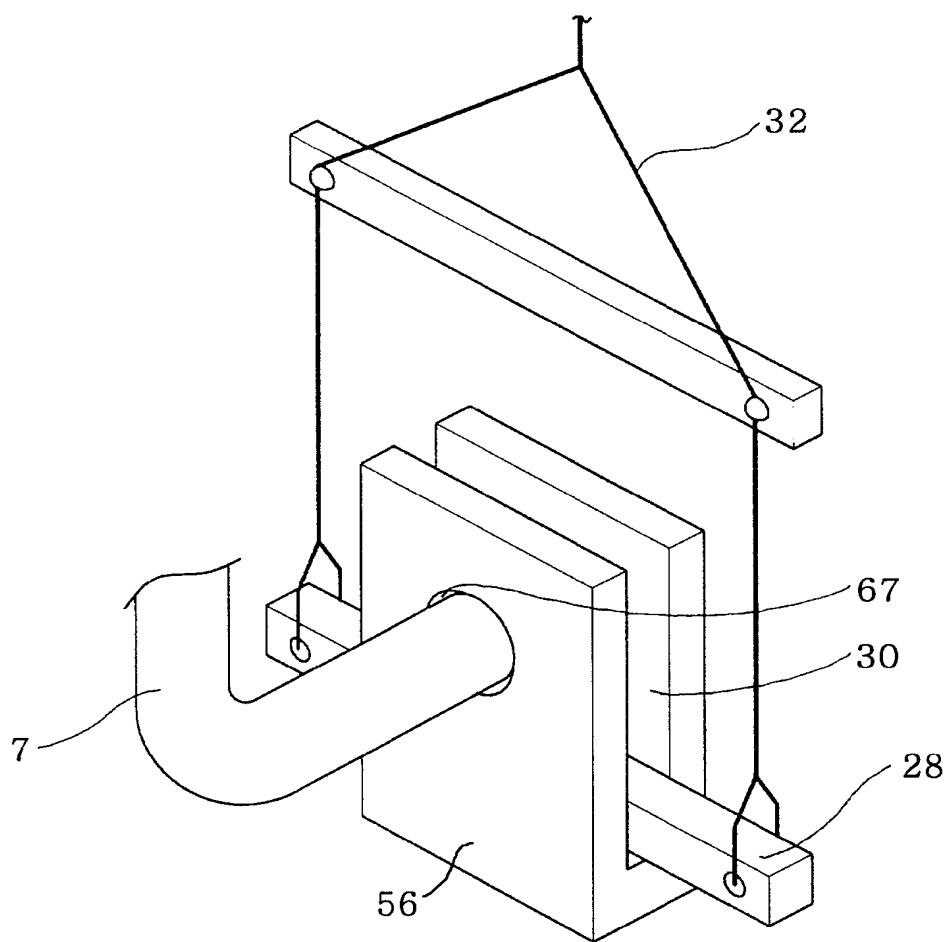
4/19

FIG.4



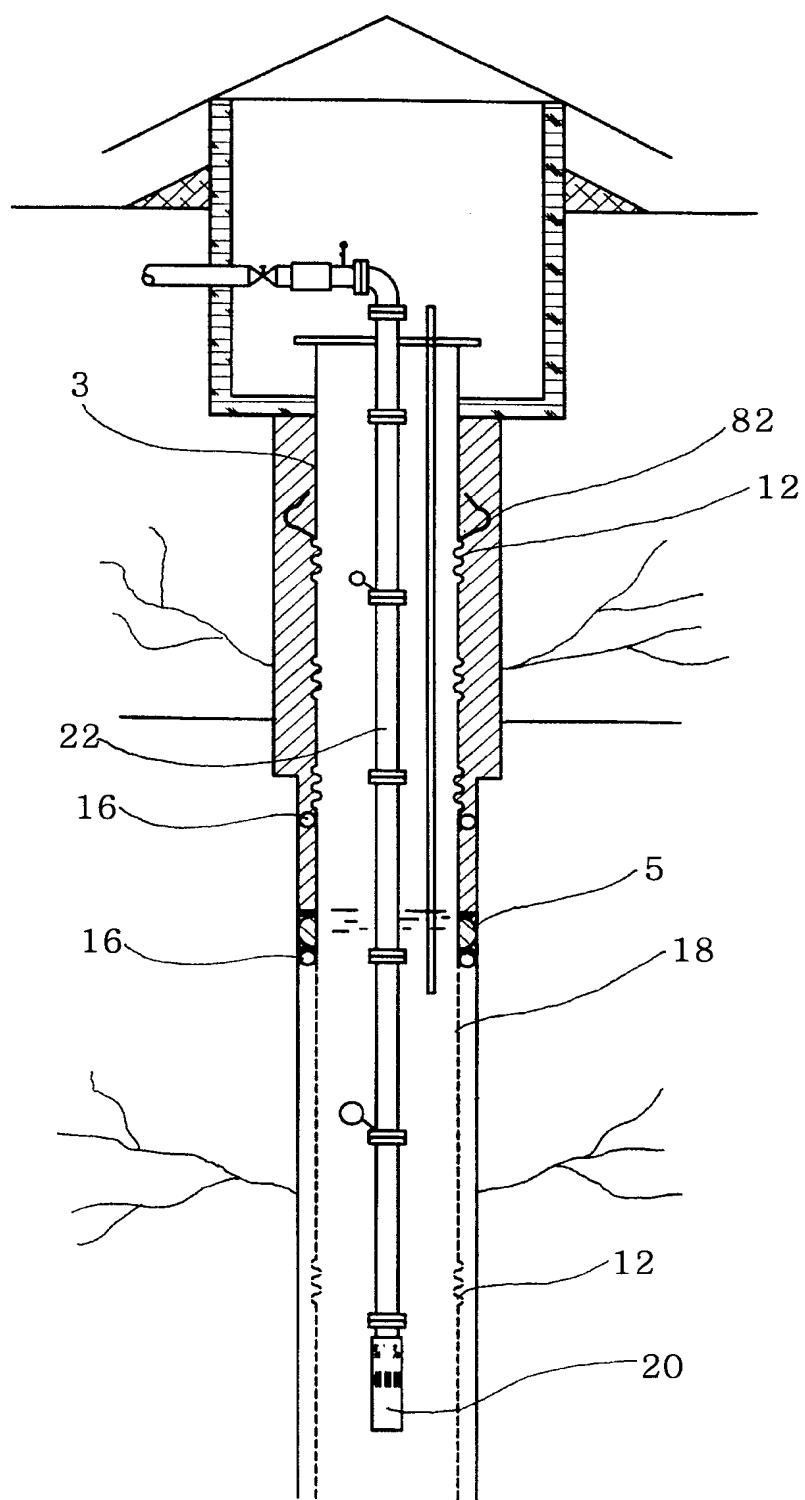
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FIG.5



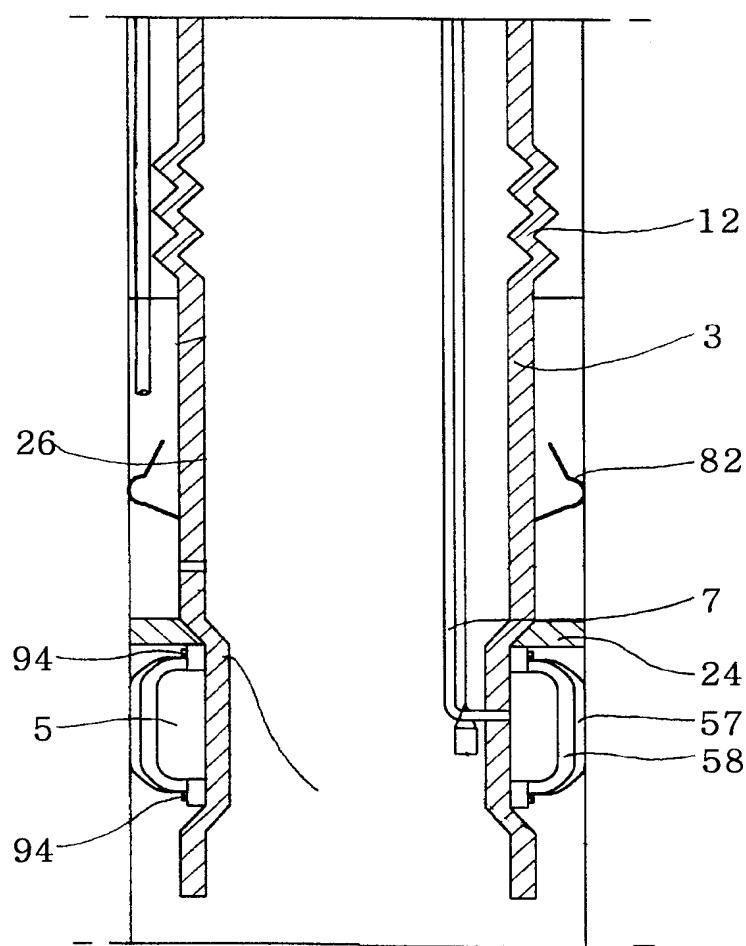
6/19

FIG.6



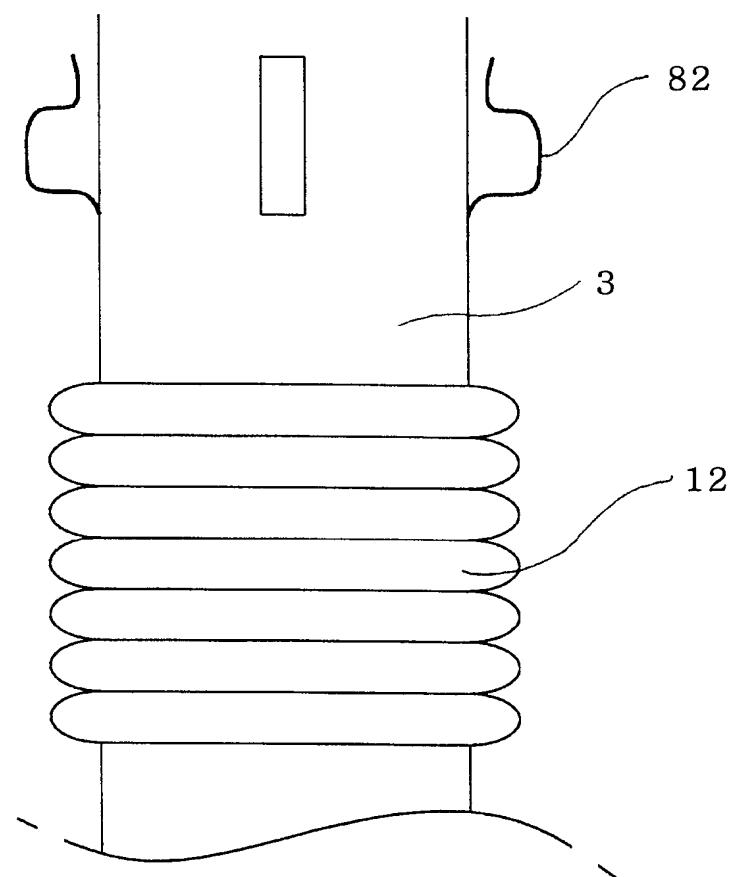
7/19

FIG.7



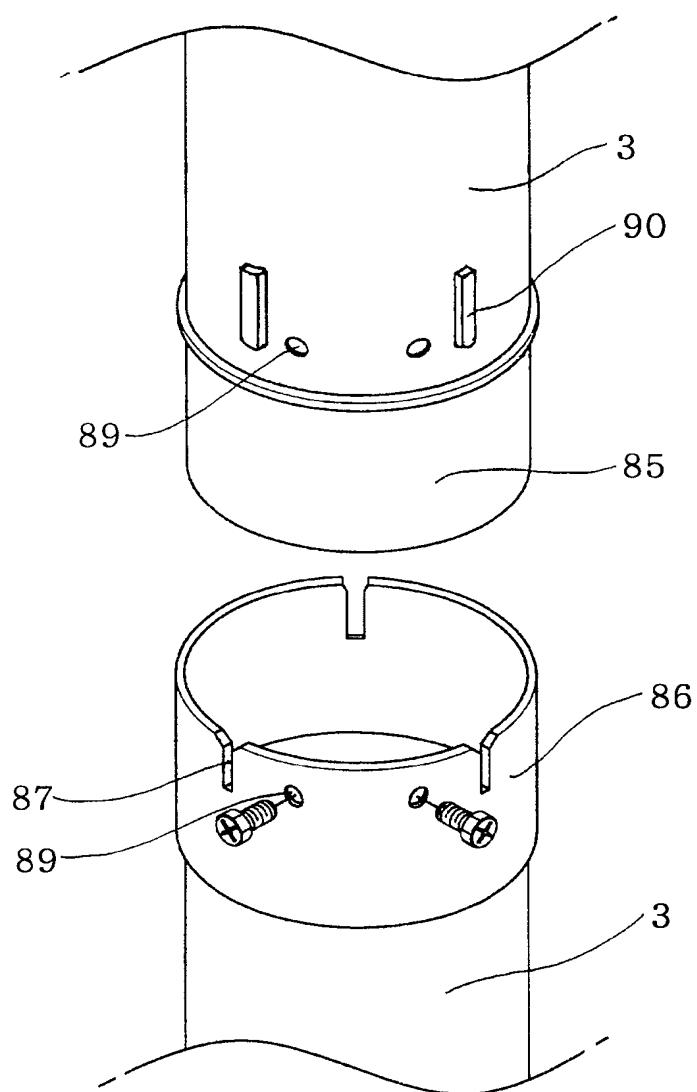
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FIG.8



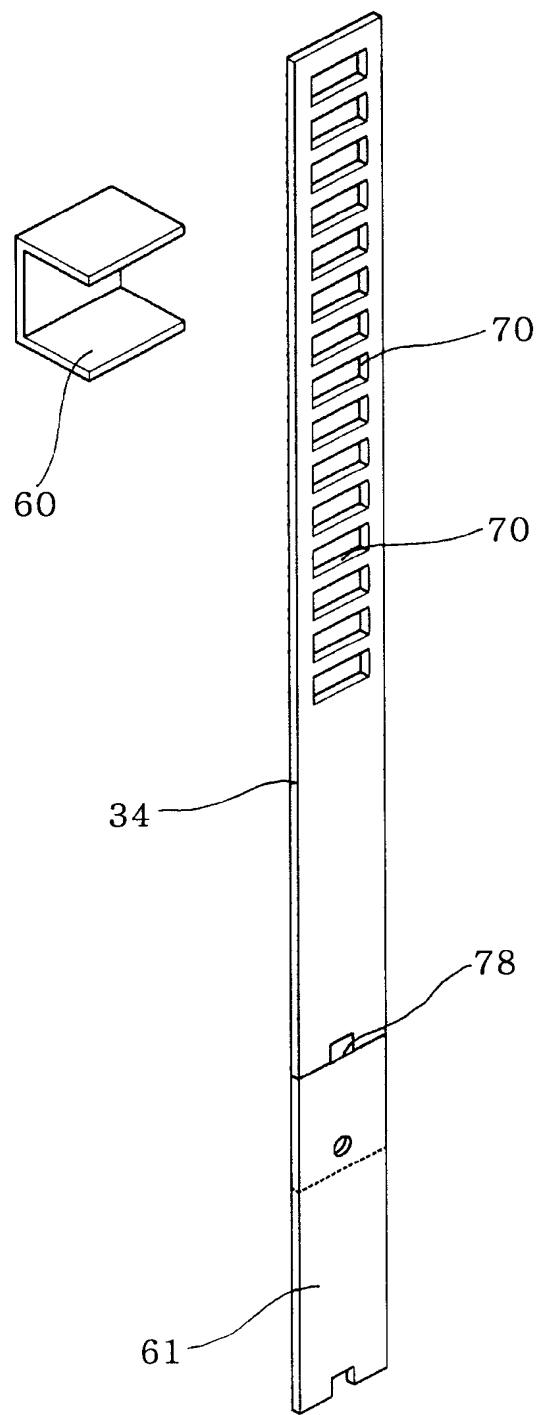
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FIG.9



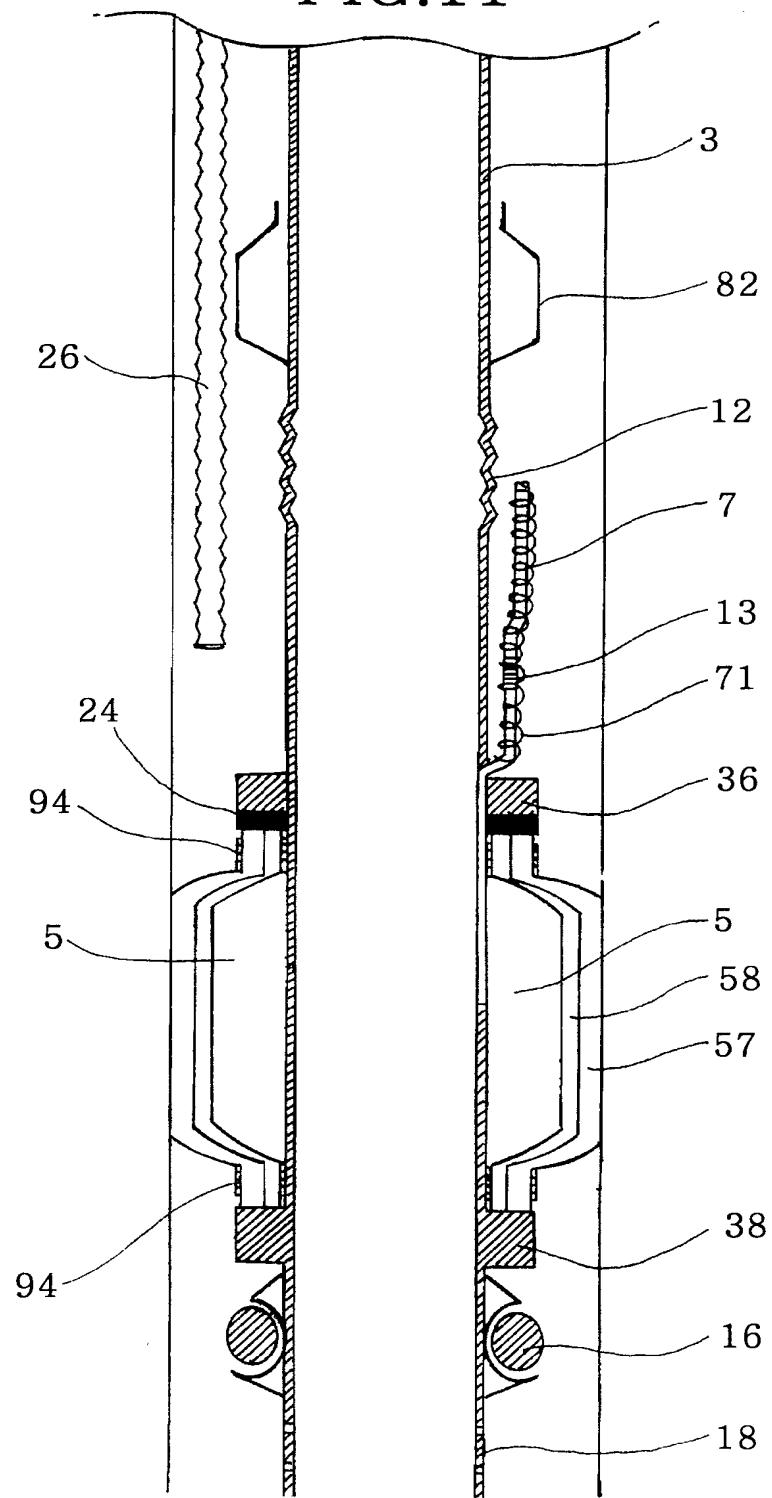
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FIG.10



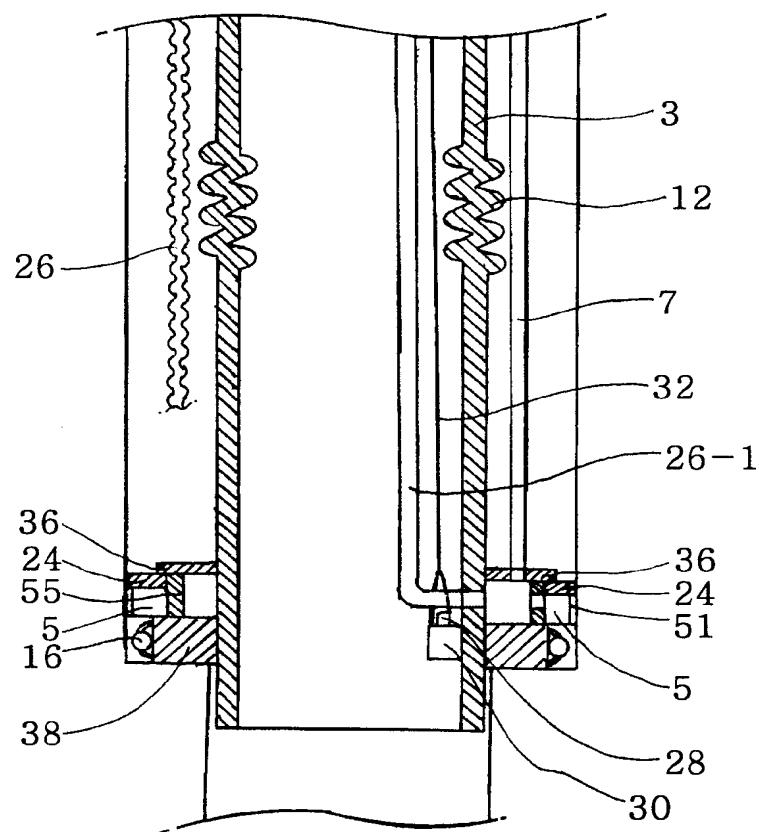
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FIG.11



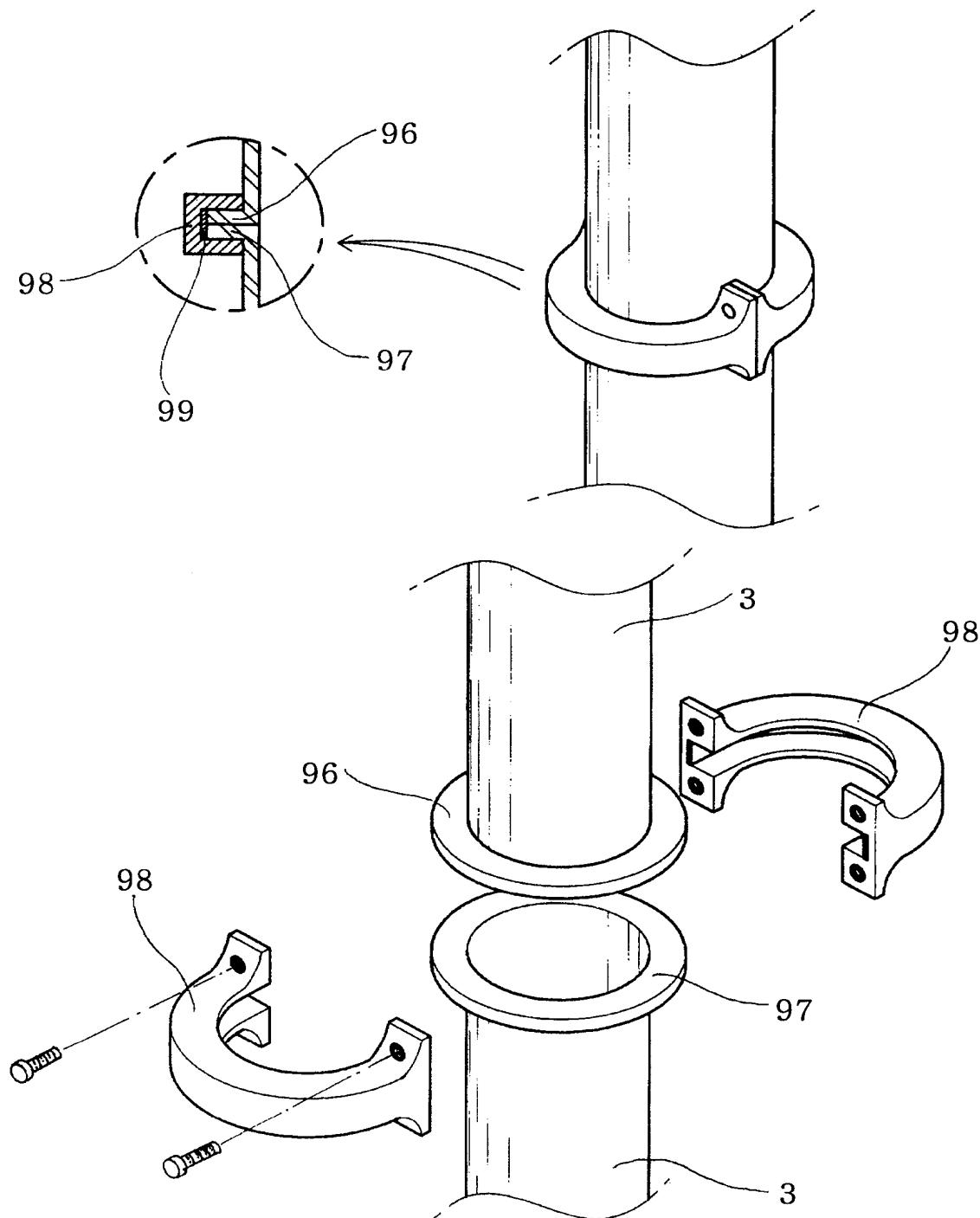
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FIG.12



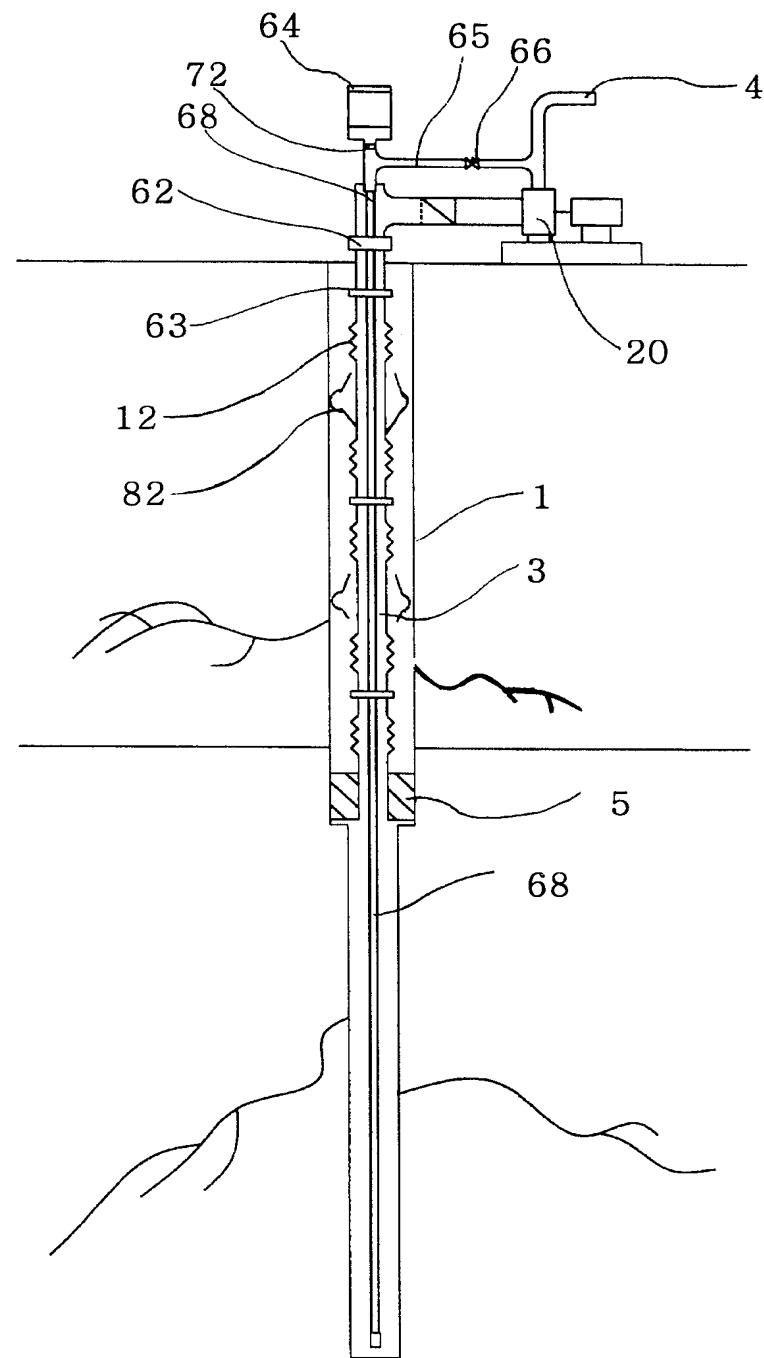
13/19

FIG.13



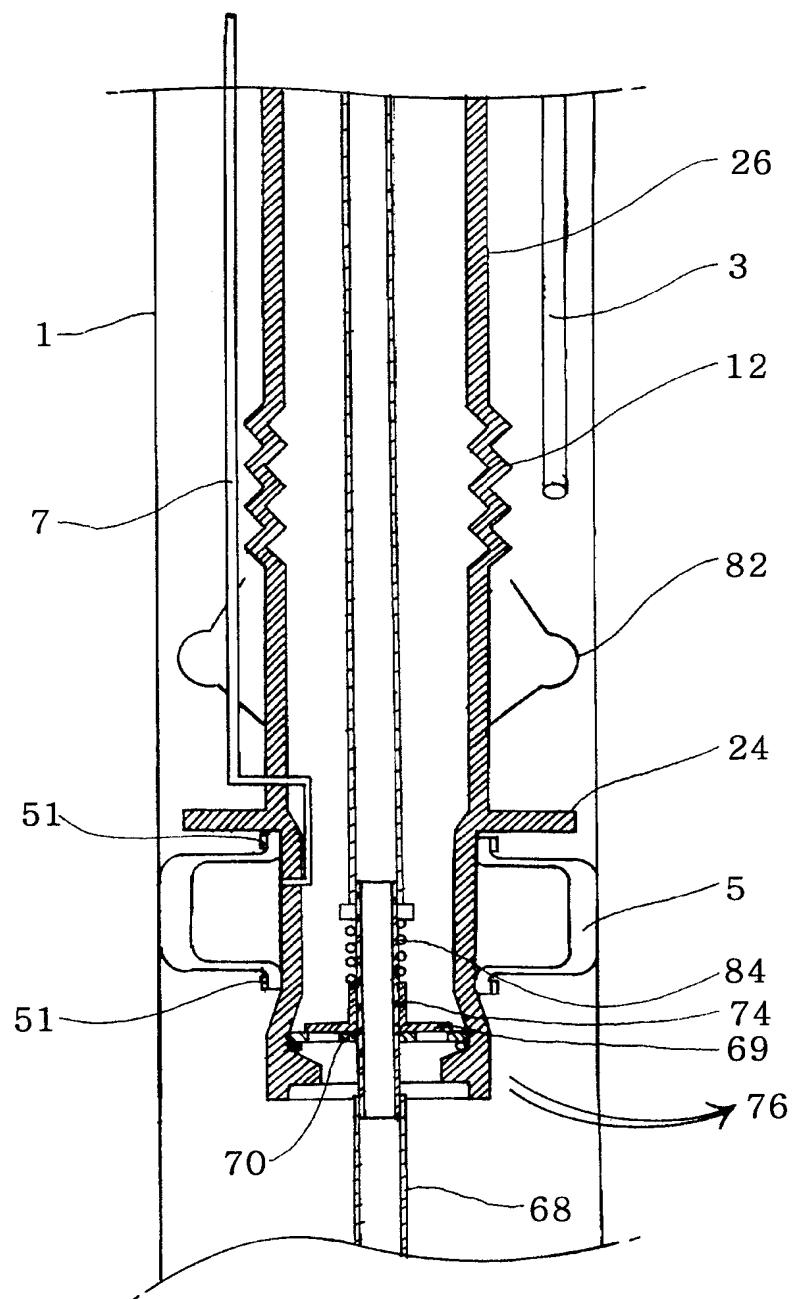
14/19

FIG.14



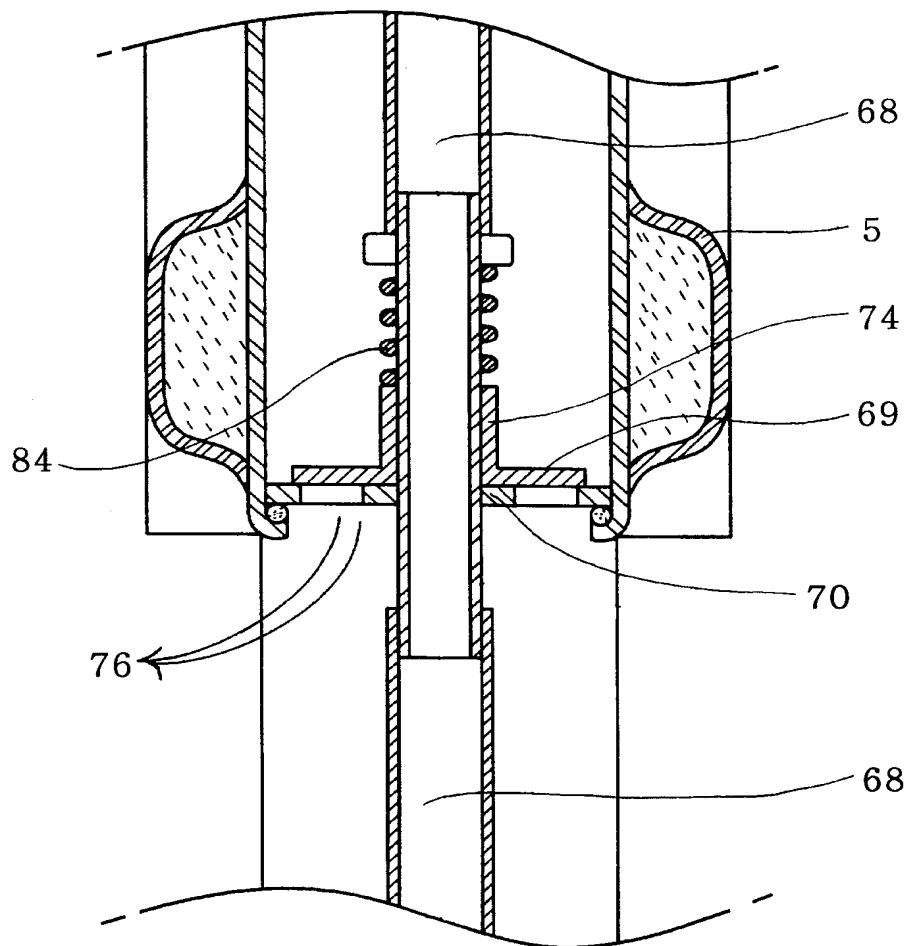
15/19

FIG.15



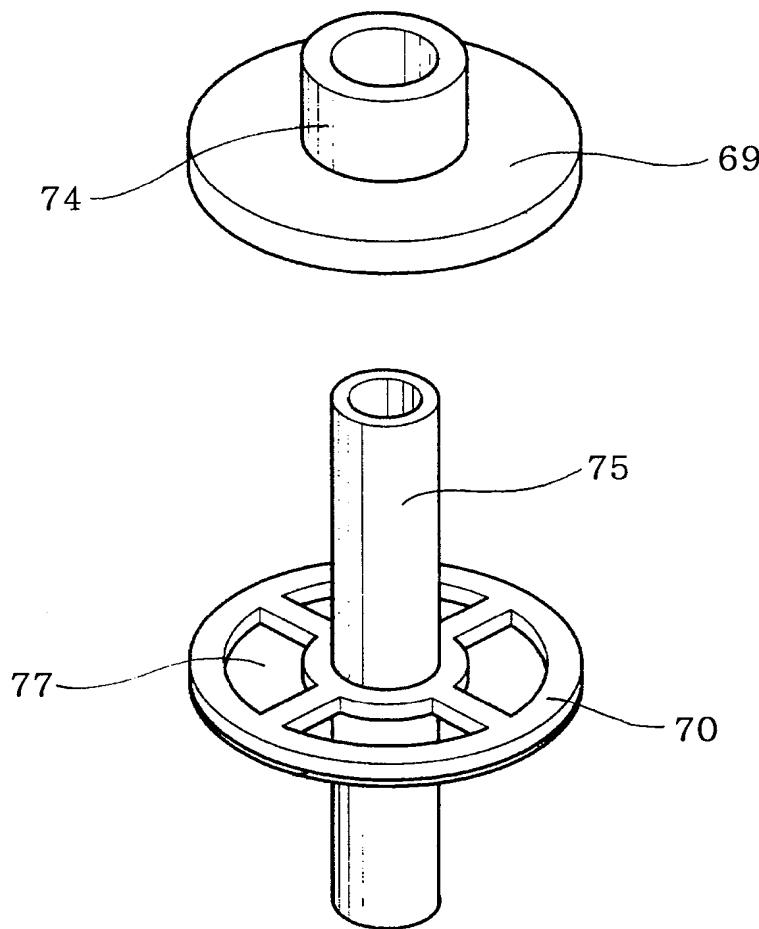
16/19

FIG.16



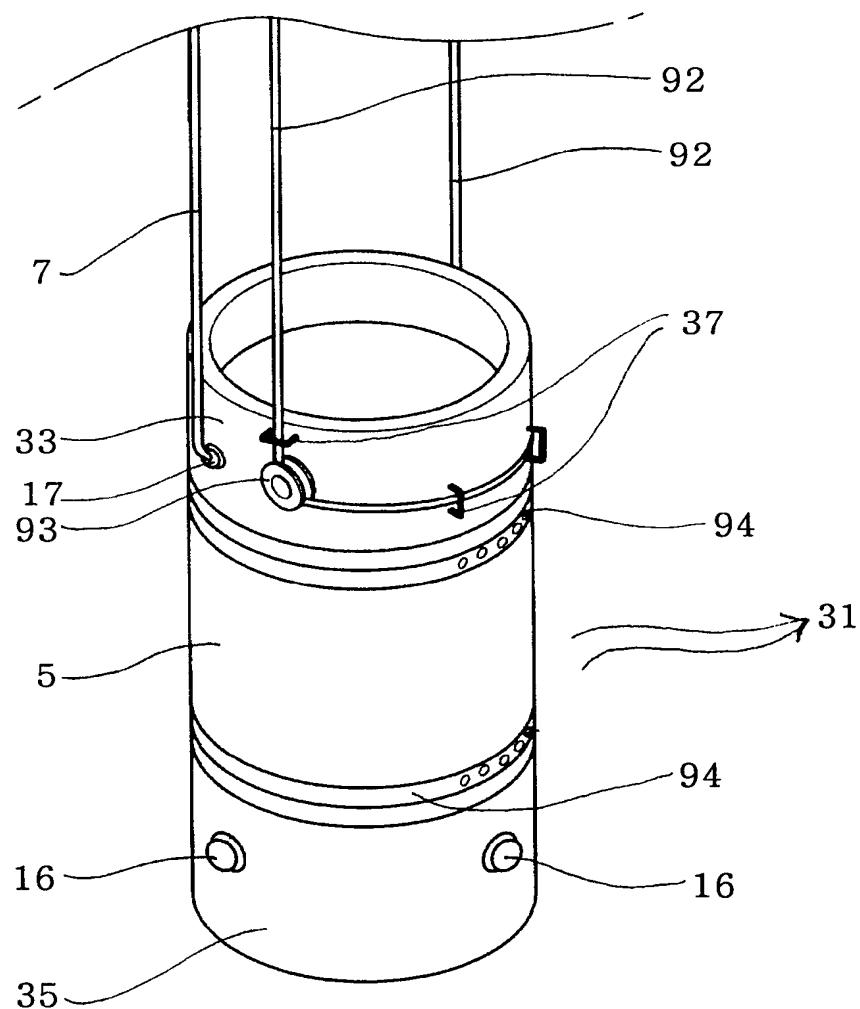
17/19

FIG.17



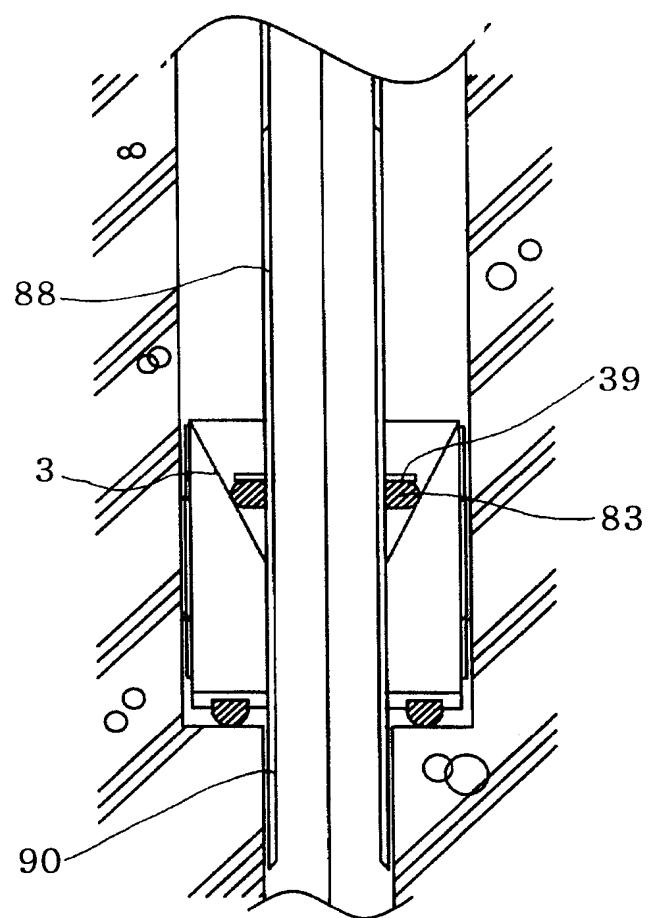
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FIG.18



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FIG.19



# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/KR 99/00458

## A. CLASSIFICATION OF SUBJECT MATTER

IPC<sup>7</sup>: E 21 B 33/14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC<sup>7</sup>: E 21 B; F 16 L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| A         | EP 0846839 A2 (HALLIBURTON) 10 June 1998 (10.06.98) fig. 1, abstract.              | 1-21                  |
| A         | US 5791378 A (STEPHENS) 11 August 1998 (11.08.98) totality.                        | 1-21                  |
| A         | US 5332037 (SCHMIDT) 26 July 1994 (26.07.94) fig. 1.                               | 1-21                  |
| A         | US 4909323 A (HASTINGS) 20 March 1990 (20.03.90) fig. 1-5.                         | 1-21                  |
| A         | US 4402551 A (WOOD) 06 September 1983 (06.09.83) fig..                             | 1-21                  |
|           | -----  |                       |

Further documents are listed in the continuation of Box C.

See patent family annex.

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  - „E“ earlier application or patent but published on or after the international filing date
  - „L“ document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  - „O“ document referring to an oral disclosure, use, exhibition or other means
  - „P“ document published prior to the international filing date but later than the priority date claimed
- „T“ later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- „&“ document member of the same patent family

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|--|---|
| Date of the actual completion of the international search<br><br>08 November 1999 (08.11.99)                                   | Date of mailing of the international search report<br><br>13 December 1999 (13.12.99) |
| Name and mailing address of the ISA/AT<br>Austrian Patent Office<br>Kohlmarkt 8-10; A-1014 Vienna<br>Facsimile No. 1/53424/200 | Authorized officer<br><br>Wankmüller<br><br>Telephone No. 1/53424/415                 |

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
PCT/KR 99/00458

| Im Recherchenbericht<br>angeführtes Patentdokument<br>Patent document cited<br>in search report<br>Document de brevet cité<br>dans le rapport de recherche | Datum der<br>Veröffentlichung<br>Publication<br>date<br>Date de<br>publication | Mitglied(er) der<br>Patentfamilie<br>Patent family<br>member(s)<br>Membre(s) de la<br>famille de brevets | Datum der<br>Veröffentlichung<br>Publication<br>date<br>Date de<br>publication   |
|--|--|--|--|
| EP A2 846839   | 10-06-1998   | CA AA 2220385<br>EP AJ 846839<br>NO AO 974983<br>NO A 974983<br>US A 5829526                             | 12-05-1998<br>27-10-1998<br>29-10-1997<br>13-05-1998<br>03-11-1998               |
| US A 5791378   | 11-08-1998   | US A 5427154<br>CA AA 2030828<br>GB A0 9026410<br>GB A1 2239301<br>US A 5063967<br>US A 5241993          | 27-06-1995<br>07-06-1991<br>23-01-1991<br>26-06-1991<br>12-11-1991<br>07-09-1993 |
| US 5332037   |  | keine - none - rien  |  |
| US A 4909323   | 20-03-1990   | keine - none - rien  |  |
| US A 4402551   | 06-09-1983   | keine - none - rien  |  |